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(56) Documents Cited
GB 1569028 A
EP 0133920 A1
US 6149819 A
US 4224154 A
US 4016079 A
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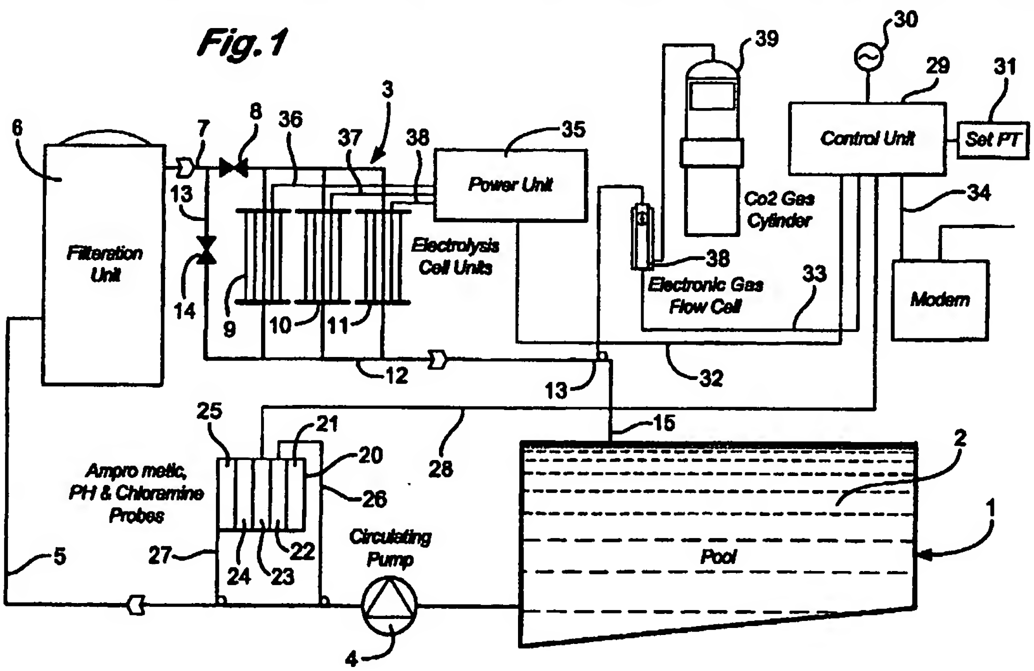
(54) Abstract Title
Maintaining the water in a swimming pool in a safe state

(57) Water 2 in a swimming pool 1 is maintained in a safe state by a maintaining the concentration of chlorine at a predetermined level by introducing chlorine in response to a signal from a free chlorine sensor 22, where the predetermined level is increased in response to a signal indicating the presence of chloroamines in the water. The concentration of chloramines maybe determined by comparing the outputs of the free chlorine sensor 22 and an oxidation reduction potential probe (ORP) sensor 23 or directly. The chlorine may be generated by an electrolytic cell 9, 10, 11. Carbon dioxide may be injected into the water to control the pH. This system maintains the swimming pool water in a safe state by helping to reduce the chloramine concentration.

Fig. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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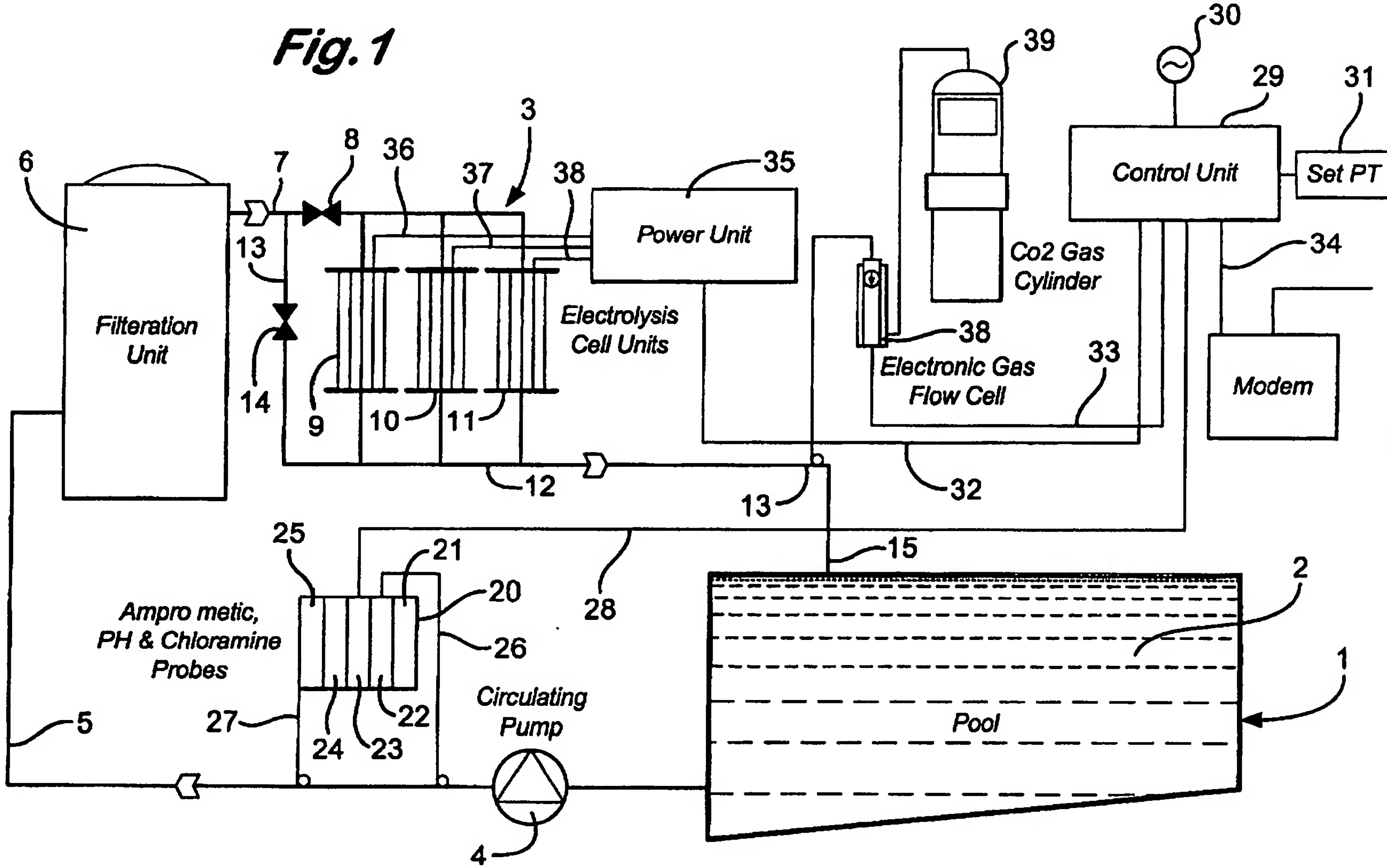
Filteration Unit
Electrolysis Cell Units
Power Unit
Co2 Gas Cylinder
Electronic Gas Flow Cell
Control Unit
Set PT
Modem
Ampro metic, PH & Chloramine Probes
Circulating Pump
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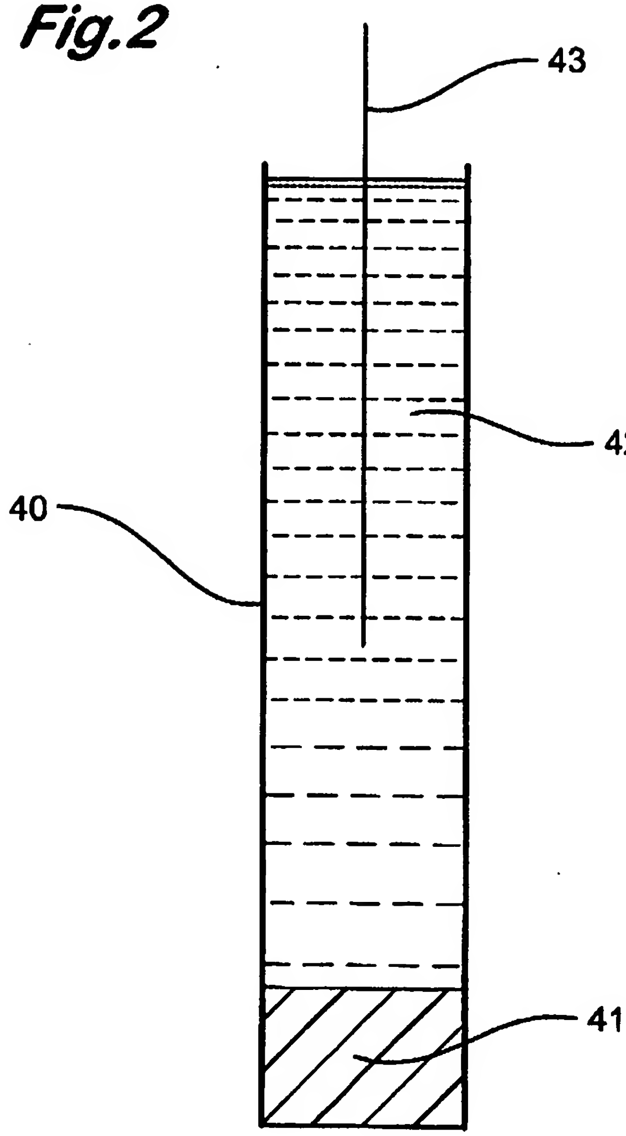
Fig. 1

Fig.2



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Method and Apparatus for maintaining the water in a swimming pool in a safe state

This invention relates to a method and apparatus for maintaining the water in a swimming pool in a safe state.

When a swimming pool is first filled with potable tap water the water is clear and safe to swim in. The human body has nine or ten orifices through which body fluids can enter the water when a person is swimming. These body fluids contain bacteria which quickly multiply in the warm water and, if left untreated, could make subsequent swimmers sick.

In order to maintain the water in a safe condition it is usual to introduce an oxidizing agent into the water. In the majority of public swimming pools the oxidizing agent is gaseous chlorine although ozone is sometimes used. Where chlorine is the oxidizing agent, it becomes hydrolysed to hypochlorous acid which is the effective disinfecting agent, being a weak acid which dissociates into hydrogen ions and hypochlorite ions. In the case of domestic pools chemicals such as sodium hypochlorite and calcium hypochlorite are commonly used. Hyprochlorous acid is also formed when e.g. sodium hyprochlorite or calcium hypochlorite are dissolved in water. Chlorine or "free chlorine" as used herein means chlorine from any of the above sources which can participate in an oxidation reaction and maintain a swimming pool in a safe state

At the risk of some oversimplification the oxidizing agents, either directly or indirectly via a series of chemical reactions, oxidize and kill the bacteria. They also react with the body fluids and other organic material which may enter the water, for example on the feet of bathers or as dust and dirt blown into the water by the wind.

Provided that sufficient oxidizing agent is used the

water can be maintained in a safe state. If insufficient oxidizing agent is used then the water will not be safe. Where the oxidizing agent is chlorine chloramines are produced predominantly NH_2Cl with lesser amounts of $NHCl_2$, NCl_3 and organic chloramines. These compounds have an extremely unpleasant smell which is often attributed by the general public to the swimming pool operator using too much chlorine. Perversely, the technical solution is to add more chlorine.

An additional important factor is that the water in the swimming pool should look and feel good. If the pH of the water falls below 7.1 or rises above 7.5 then the swimmer tends to itch and feel uncomfortable. At a pH of 7.3 the water takes on a sparkle which makes the water appear extremely inviting. Coincidentally, the chlorine also works extremely efficiently when the pH is 7.3 which make this an ideal pH at which to operate.

Whilst using a small surfeit of chlorine appears to do little harm other than to bleach bathing costumes and human hair ("red eye" is caused by chloramines and not chlorine) the chlorine itself is expensive, particularly when used in the quantities required by public pools which are frequented by numerous children. It is therefore desirable to regulate the quality of chlorine or (or hypochlorite producing chemicals) used in an appropriate manner.

As a result of practical experience local authorities general recommend that a level of above 2ppm chlorine be maintained in a public swimming pool whilst a level of 0.5ppm is quite acceptable for a small private pool.

The level of chlorine is controlled by a control circuit including a sensor.

At the present time the most commonly used sensor is the ORP (Oxidation Reduction Potential probe), which is

also known as a 'Redox' sensor. This sensor is inexpensive (about £40) and needs little skilled maintenance. The ORP sensor produces an output potential which is indicative of the total chlorine present. Typically this will comprise free chlorine and chloramines.

It will be appreciated that an ORP sensor may give the same reading when the water contains an appropriate concentration of free chlorine and no chloramines and when the water contains little or no free chlorine and a large quantity of chloramines. This condition is sometimes observed in 25m pools after they have been used all day by young schoolchildren. The final result is that although the ORP sensor is giving what appears to be the desired reading the water is full of chloramines and has a distinctly unpleasant smell.

An alternative sensor is known as a "free chlorine" sensor. This is far more expensive (about £900) but detects the free chlorine present which diffuses through a permeable membrane in the sensor.

The advantage of using this sensor is that the free chlorine can be maintained at the desired concentration since the concentration of chlorine in the water can be measured independent of the concentration of chloramines. Thus, if there is a large increase in the concentration of chloramines caused by a group of urinating infants the control loop will keep the required concentration of chlorine which will slowly but surely dispose of the chloramines. It will be appreciated that there is much to commend an early morning swim in these pools over a late evening dip.

The present invention is based on the inventor's premise that whilst it is highly desirable to enjoy the benefits of the free chlorine sensor for normal operation it would be highly desirable to be able to increase

chlorine levels as and when chloramines are present in the pool.

Accordingly to the present invention there is provided a method of maintaining the water in a swimming pool in a safe state which method comprises the step of

1) maintaining the concentration of chlorine in the water at a predetermined level by introducing chlorine in response to a signal from a free chlorine sensor;

characterized by the step of

2) increasing said predetermined level in response to a signal indicative of the presence of chloramines in said water.

A simple way of determining the presence of chloramines is to compare the outputs of an ORP sensor and a free chlorine sensor and to assume that any difference is due to the presence of chloramines.

Typically, if a small quantity of chloramines is detected the predetermined level of chlorine might conveniently be increased from 2ppm to 3ppm. If the outputs are sensed at a specified later time, perhaps after 30 minutes and no chloramines are detected the predetermined level of the chlorine might be returned to its original 2ppm level. Alternatively, if the level of chloramines had not decreased, or indeed increased, the set point could be increased further.

Whilst the ORP sensor can be used as described above its reading can be influenced by other factors, for example the presence of tiny quantities of rust in the water from corroding pipes. For this reason it would be desirable to be able to measure the concentration of chloramines directly.

One device for doing this is a probe which comprises a tube the bottom of which is provided with a support containing an ionophore which is receptive to chloramines

or a particular chloramine species produced by oxidation, e.g. NH_2Cl. The tube contains a filling solution, for example ammonium chloride which rests on the support and contains the bottom of a silver wire. When the probe is placed in the water the chloramine-derived ions are received within the ionophore and a potential is generated in the silver wire which is related to the concentration of chloramines in the water. The ionophore is not receptive to free chlorine and hence gives a reading which is unaffected thereby. The potential is preferably compared with the potential from a standard reference cell which is also in contact with the same water.

Further features are set out in the claims.

For a better understanding of the present invention reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a flowsheet showing an apparatus in accordance with the present invention connected to a swimming pool; and

Figure 2 is a schematic side elevation of a probe.

Referring to Figure 1 there is shown a swimming pool which is generally identified by the reference numeral 1.

The swimming pool 1 contains water 2 which is kept in safe and attractive condition by apparatus which generally identified by the reference numeral 3.

The apparatus 3 comprises a circulating pump 4 which pumps the water 2 through pipe 5 into a standard filtration unit 6 which removes leaves and solid particles. The filtered water leaves the filtration unit 6 through a pipe 7 and passes through valve 8 and one of three chlorination units 9, 10 and 11 before being introduced into pipe 12. A bypass line 13 having a valve 14 is provided so that water can be circulated whilst maintenance is carried out on the chlorination units 9, 10 and 11.

The pipe 12 is provided with a venturi 13 through which gaseous carbon dioxide from a cylinder 14 can be introduced into the water as requested to adjust its pH.

Finally, the chlorinated and pH adjusted water is returned through pipe 5 into the swimming pool 1.

The amount of chlorine and carbon dioxide which are introduced into the water is requested by a control system which comprises a sensor block 20 which contains:

21 a pH cell;

22 a free chlorine sensor;

23 an ORP sensor;

24 a temperature sensor; and

25 a standard cell

In use, a small flow of water 2 is passed through the sensor block 20 via supply tube 26 and returned via return tube 27. The signals from the sensor block 20 are sent along multistrand cable 28 to a control unit 29 which can be visualized as a small computer.

The control unit 29 is provided with:

30 a power supply;

31 a set point input;

32 a chlorine control line;

33 a carbon dioxide control line; and

34 a modem.

The chlorine control line 32 is connected to a rheostat in chlorination units 9, 10 and 11 via electric cables 35, 36 and 37 respectively.

The carbon dioxide control line is connected to a flow cell 38.

The operation of the apparatus 3 will now be described. To facilitate understanding it will be assumed that the swimming pool 1 has been cleaned and newly filled with fresh tap water which will be free of chloramines.

As the swimming pool is filled the water 2 is dosed with table salt to a concentration of about 3g/l. This concentration of salt is virtually imperceptible to the human tongue and gives the water a very slightly soft, soapy feel which many people find attractive. The salt is used in the production of chlorine in the chlorination units 9, 10 and 11 as will hereinafter be described.

The circulatory pump 4 is activated and the water flows through the filtration unit 6, the chlorination units 9, 10 and 11, the venturi 13 and returned to the swimming pool 1.

The sample of water passing through the block 20 has:

21 pH = 7.4;

22 free chlorine 0.1ppm;

23 chloramines = 0; and

24 temperature = 76°F (24.7°C)

As discussed above the optimum pH is 7.3 which is preset in the control unit 29. However, the free chlorine level depends on the use of the pool (public or domestic) and local regulations. Accordingly, the desired chlorine level (say 2ppm) is entered into the set point input 31.

Dealing firstly with the chlorine, the control unit 29 notes that chlorine is required and sends a signal to the chlorine control unit 35 which applies a DC potential across the chlorination units 9, 10 and 11.

Each chlorination unit 9, 10 and 11 comprises a multi-plate electrical cell which electrolysis the water 2 (dilute brine) to form chlorine which enters the water. The plates which are used in each electrical cell are extremely expensive and have a limited lifespan when operated at their rated voltage (20V DC). Previously it has been the practice to operate these cells in a digital manner, i.e. to wait for the chlorine level to fall to a certain level, activate the cells at their rated voltage until the level of chlorine reaches the set point and then switch the cells off. We have found that the longevity of the plates can be very significantly increased by operating the cells in an analogue manner, i.e. adjusting the potential in accordance with the difference between the actual and the desired chlorine level. In experimenting on the inventor's private pool the plates show absolutely no sign of deterioration at a time when the plates of previous chlorination units could be expected to need replacement. The build up of calcium on the plates can be inhibited by periodically reversing the polarity of the plates.

Without wishing to be bound by theory it appears

that the chlorine which enters the water reacts rapidly to form hypochorous acid

$$Cl_2 + H_2O \rightarrow HOCl + Cl^- + H^+$$

which is the most germicidal of all chlorine compounds expect chlorine dioxide. Hypochlorous acid is a weak acid which undergoes partial dissociation as follows:

$$HOCl \rightarrow H^+ + OCl^-$$

The degree of dissociation is proportionate to the pH. In water of pH between 6.5 and 8.5 the reaction is incomplete and both species are present to some degree. The sum of the HOCl and OCl^- values determines the "free chlorine". Chlorine in the form of chloramines is hereinafter referred to as "combined chlorine".

Once properly chlorinated, carbon dioxide is injected into the water to adjust its pH to the desired value of 7.3 before the water is returned to the swimming pool 1. In this connection it should be noted that the chlorination process described does result in the electrolysed water (brine) becoming slightly alkaline.

For the purpose of illustration we will now assume that the swimming pool 1 is a public pool and that it is half term. Typically the swimming pool 1 will be crowded from early morning to late evening with mothers, babies, young children, teenagers and adults. Each person will discharge sweat into the water which will be mixed with the inevitable urine from babies and young children, sometime faeces from babies and body fluid washed from the bodies.

As this matter passes into the water it is seized upon by the chlorine. However, at peak times the available chlorine is rarely sufficient resulting in the swimming pool 1 taking on the "chlorine" smell of chloramines.

One previous solution to this problem has been for the pool operator to increase the set point of a free

chlorine sensor to a higher level and one local authority uses a set point of 8ppm with great success - (no peculiar smells, no red eye and no complaints). However, this does consume significant quantities of chlorine.

If the set point is attained the chlorine will eventually deal with the chloramines overnight and hence the water should be acceptable by the following morning.

In the present invention the concentration of chloramines is detected by the control unit 29 comparing the readings of the free chlorine sensor 22 and the ORP sensor 23. The difference is indicative of the concentration of chloramines.

In the present invention, depending on the concentration of chloramines which is sensed, the set point for the concentration of chlorine in the pool is increased, for example to 3, 4 or 5ppm chlorine. After a fixed period, for example 30 minutes the concentration of chloramines is again determined.

If no chloramines are detected then the set point is returned to it initial level, i.e. 2ppm. If chloramines are detected but in a lower concentration the level of chlorine is maintained for another 30 minutes and the situation reviewed. If the concentration of chloramines is the same or has increased the set point is raised.

It will be appreciated that this method ensues that the appearance of chloramines is promptly dealt with whilst the basic level of chlorination is maintained at all times.

The control unit 29 is also programmed to carry out certain additional functions. In particular, over a period of time bacteria can build up a tolerance to low chlorine levels. Accordingly, it is desirable to periodically shock does the water, for example by raising the chlorine level to 6ppm over a 24 hour period, to kill these bacteria."

The signal from the temperature sensor can be used in various ways. Firstly it can be used in conjunction with any heating system. Secondly it can be used to shut down the chlorination system if the water temperature falls below 10°C.

* * *

It will be appreciated that, as heretofore described the level of chloramines has been determined indirectly.

We believe that it would be desirable to measure this parameter directly since the reading of ORP sensors can be affected by outside influences, such as rust in the water arising from, for example the use of iron pumps.

One alternative is to use of a probe which is generally shown in Figure 2. The probe, which is generally identified by reference numeral 40 comprises a glass tube 40 one end of which is fitted with a PVC plug 41 which contains an ionophore receptive to NH_2 ions. The glass tube 40 contains ammonium chloride 42 in which is immersed the end of a silver wire 43.

In use, the bottom end of the probe 40 is dipped into the water. Without wishing to be bound by theory active ions derived from local chloramine enter the receptors in the ionophore and produce a charge therein which is reflected by the potential of the silver wire 43.

In order to utilise this potential it is compared with the potential of an electrode from a reference cell (typically a standard KCl/AgCl and the difference in potential measure by a high impedance source whose output is fed to the control unit 29 for control purposes.

A solid state equivalent of the apparatus of Figure 2 is available from the applicants.

Various modifications to the arrangement described are envisaged, for example a water heating unit may be

provided which could have an independent feed and return or could be situated between the filter and the chlorination units.

Whereas the chlorination units generate chlorine electrolytically they could be replaced by one or more cylinders of chlorine gas arranged to introduce the desired quality of chlorine into the water.

CLAIMS

1. A method of maintaining the water in a swimming pool in a safe state which method comprises the step of

   1) maintaining the concentration of chlorine in the water at a predetermined level by introducing chlorine in response to a signal from a free chlorine sensor;

characterized by the step of

   2) increasing said predetermined level in response to a signal indicative of the presence of chloramines in said water.

2. A method according to Claim 1, wherein the concentration of chloramines is determined by comparing the outputs of a free chlorine sensor and an ORP sensor.

3. A method according to Claim 1, wherein the concentration of chloramines is determined directly.

4. A method according to Claim 1, 2 or 3, wherein said chlorine is produced electrolytically in an electrolytic cell and the electrical potential applied to each electrolytic cell is varied according to the demand.

5. A method according to Claim 4, wherein said electrolytic cell contains an anode plate and a catode plate and said method includes the step of periodically changing the duties of said plates to inhibit the build up of calcium thereon.

6. An apparatus for carrying out a method according to Claim 1, said apparatus comprising:

   (i) a free-chlorine sensor (22);

   (ii) means for determining the concentration of chloramines present;

   (iii) a control unit (29);

   (iv) means for introducing chlorine into the water in response to a signal from said free-chlorine sensor (22) and a set point (31); and

(v) means for adjusting said set point in response to a signal from said means (ii) indicative of the presence of chloramines.

7. An apparatus as claimed in Claim 6, wherein said means (ii) for determining the concentration of chloramines present comprises an ORP sensor and means to sense a difference in the output of said free-chlorine sensor (22) and the ORP sensor indicative of the presence of chloramines when said apparatus is in use.

8. An apparatus as claimed in Claim 6, wherein said means (ii) for determining the concentration of chloramines present comprises an ionophore.

9. An apparatus as claimed in Claim 6, 7 or 8, including at least one chlorination unit (9,10, 11).

10. An apparatus as claimed in Claim 9, wherein saic chlorination unit comprises an electrolytic cell.

11. An apparatus as claimed in Claim 10, including a chlorine control unit (35) adapted to provide said electrolytic cell with cell with different DC voltages in response to signals received from said control unit (29).

12. An apparatus as claimed in any of Claims 6 to 11, including means to inject carbon dioxide into said water to reduce the pH thereof.

13. An apparatus for maintaining the water in a swimming pool in a safe state substantially as hereinbefore described with reference to and as shown in Figure 1 of the accompanying drawings or as modified as shown in Figure 2 thereof.

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INVESTOR IN PEOPLE

Application No: GB 0027682.4
Claims searched: 1 to 13

Examiner: Graham S. Lynch
Date of search: 10 July 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): C1C (CP, CRCG, CRCH, CSCG, CSCH, CTCG, CTCH)

Int Cl (Ed.7): C02F 1/00, 1/50, 1/76

Other: On-line : WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 1569026 SAUNIER et al. Whole document.	
X	EP 0133920 A1 OLIN. Whole document.	1, 2, 4, 6, 7, 9, 10, 11.
A	US 6149819 MARTIN et al. Whole document.	
A	US 4224154 STEININGER. Whole document.	--
A	US 4016079 SEVERIN. Whole document.	
A	WPI Abstract Accession No.1999-064005 & JP 100309583. MATSUSHITA. See accompanying abstracts.	
A	WPI Abstract Accession No.1998-162852 & JP 100028981. ORGANO CORP. See accompanying abstracts.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		